RECEIVED
CENTRAL FAX CENTER
OCT 2 6 2006

EH-11132

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Applicant	BULLIED et al.
Serial No.	10/809,072
Confirmation No.	6990
Filing Date	March 25, 2004
For	SINGLE CRYSTAL INVESTMENT CAST COMPONENTS AND METHODS OF MAKING SAME
Examiner	Kuang Y. Lin
Art Unit	1725

Mail Stop Appeal Brief – Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

APPEAL BRIEF
PURSUANT TO 37 C.F.R. § 41.37

Dear Sir:

This Appeal Brief is being filed in response to the Notice of Appeal filed July 26, 2006 and the Final Office Action mailed May 26, 2006, rejecting claims 1-12, 15, 17-30 and 33-35 of the above-identified Application.

I. REAL PARTY IN INTEREST

The real party in interest for this appeal is the assignee of this application:

United Technologies Corporation
1 Financial Plaza
Hartford, Connecticut 06101

This assignment was recorded at Reel/Frame: 015152/0263 on 03/25/2004.

10/27/2006 TL0111 00000027 210279 10809072
02 FC:1402 500.00 DA

II. RELATED APPEALS AND INTERFERENCES

There are no related pending or prior appeals, interferences, or judicial proceedings know to Appellants, Appellants' legal representatives, or the Assignee which may be related to, directly affect, be directly affected by, or have a bearing on, the Board's decision in this appeal.

III. STATUS OF CLAIMS

Claims 13-14, 16 and 31-32 have been cancelled. Claims 1-12, 15, 17-30 and 33-35 remain pending in this application and are being appealed herein. A copy of the claims is attached hereto in the Claims Appendix.

IV. STATUS OF AMENDMENTS

No Amendment was filed subsequent to the Final Rejection dated May 26, 2006.

V. SUMMARY OF CLAIMED SUBJECT MATTER

The present invention relates to investment casting systems and methods that utilize seed crystals, grain selectors, and grain selector supports to produce high performance single crystal investment cast components. Generally, it has been believed that the use of grain selectors is not necessary, and is often not even desired, when seed crystals are used. (¶ [0024], lines 1-2.) However, it has been found that utilizing grain selectors in addition to seed crystals helps improve production yields and promote the formation of the optimum desired crystal structures in the final single crystal investment cast components, especially in the presence of bad or noisy crystal growth starts. (¶ [0024], lines 2-5.)

As set forth in claim 1, the investment casting system (10) comprises: an investment molding cavity (28) (¶ [0023], lines 4-6.); a seed crystal starter cavity (32) (¶ [0023], lines 4-6.); a seed crystal (34) (¶ [0023], lines 4-6.) for initiating epitaxial crystal growth in molten metallic material that comes into contact therewith (¶ [0026], lines 1-4.); a grain selector (30) (¶ [0023], lines 4-6.) operatively connecting the seed crystal starter cavity (32) and the investment molding cavity (28) (¶ [0028], lines 1-2; (¶ [0029], lines 1-2.) for at least one of: (1) selecting a single crystal from the seed crystal (34) to

grow into the molten metallic material during solidification(¶ [0024], lines 6-9.), or (2) ensuring that a single crystal from the seed crystal (34) continues to grow into the molten metallic material during solidification (¶ [0028], lines 2-4.); and a grain selector support (36) (¶ [0029], lines 5-7.) for at least partially supporting the weight of the investment molding cavity (28) and any molten metallic material contained therein to take at least a portion of this weight off the grain selector (30) (¶ [0029], lines 5-7.), wherein the system (10) is capable of producing a single crystal investment cast component (¶ [0031], lines 1-2.), and wherein the grain selector (30) comprises a non-linear tubular structure comprising a helix, a three-dimensional bend, a staircase, and/or a zigzag configuration (¶ [0028], lines 6-10.).

As set forth in claim 2, the seed crystal (34) comprises a single crystal grain structure. (¶ [0026], lines 1-2.)

As set forth in claim 3, the seed crystal (34) comprises a cross section of at least one of the following shapes: circle, square, rectangle, oval, semicircle, and polygon. (¶ [0025], lines 1-6.)

As set forth in claim 4, the seed crystal (34) comprises a cross-sectional area of about $0.0007in^2$ to about $0.625in^2$. (¶ [0025], lines 8-9.)

As set forth in claim 5, the seed crystal (34) comprises a height wherein the top of the seed crystal (34) extends into the furnace (11) far enough that a temperature of the top of the seed crystal (34) exceeds a liquidus temperature of the seed crystal (34), while a temperature of the bottom of the seed crystal (34) remains below a solidus temperature of the seed crystal (34). (¶ [0025], lines 9-13.)

As set forth in claim 6, the seed crystal (34) comprises <001> primary and secondary crystallographic orientations. (¶ [0026], lines 7-9.)

As set forth in claim 7, the seed crystal (34) comprises a <111> primary orientation and a <112> or a <110> secondary crystallographic orientation. (¶ [0026], lines 7-9.)

As set forth in claim 8, a secondary orientation of the seed crystal (34) is aligned with a predetermined crystal plane dictated by a casting feature where controlled secondary orientation is desired. (¶ [0026], lines 9-11.)

As set forth in claim 9, the seed crystal (34) comprises a nickel-based superalloy, an iron-based superalloy, a cobalt-based superalloy, and/or a refractory-based superalloy. (¶ [0027], lines 1-3.)

As set forth in claim 10, the seed crystal (34) comprises at least one of the following alloying elements: cobalt (Co), chromium (Cr), carbon (C), iron (Fe), titanium (Ti), tantalum (Ta), aluminum (Al), molybdenum (Mo), tungsten (W), boron (B), niobium (Nb), zirconium (Zr), hafnium (Hf), yttrium (Y), rhodium (Rh), rhenium (Re), lanthanum (La), manganese (Mn), and silicon (Si), with the balance comprising nominal impurities and at least one of: nickel (Ni), iron (Fe), and/or cobalt (Co). (¶ [0027], lines 3-8.)

As set forth in claim 11, the seed crystal (34) comprises about 5 wt. % chromium, about 10 wt. % cobalt, about 5.6 wt. % aluminum, about 1.9 wt. % molybdenum, about 5.9 wt. % tungsten, about 0.1 wt. % hafnium, about 8.7 wt. % tantalum, and about 3.0 wt. % rhenium, with the balance comprising nickel. (¶ [0027], lines 8-12.)

As set forth in claim 12, the seed crystal (34) comprises a predetermined melting point such that the molten metallic material that comes into contact therewith melts back a portion of the seed crystal (34) during casting. (¶ [0027], lines 12-16.)

As set forth in claim 15, the grain selector (30) comprises a non-linear tubular structure connecting the seed crystal starter cavity (32) to the investment molding cavity (28). (¶ [0028], lines 1-2; (¶ [0029], lines 1-2.)

As set forth in claim 17, the non-linear tubular structure comprises a circle, an oval, a triangle, a rectangle, a square, and/or a polygon cross-sectional shape. (¶ [0028], lines 12-13.)

As set forth in claim 18, the non-linear tubular structure comprises a passageway therein having a cross-sectional area of about $0.00025 in^2$ to about $0.50 in^2$. (¶ [0028], lines 16-17.)

As set forth in claim 19, the non-linear tubular structure comprises a passageway therein having a cross-sectional area no greater than about 1/9 a size of a surface area of a surface of the seed crystal (34) to which the non-linear tubular structure is connected. (¶ [0028], lines 17-19.)

As set forth in claims 20-21, the helix comprises about 0.25 to about 10 turns total so that about 90° to about 3600° of rotation occurs from one end of the helix to the other. (¶ [0028], lines 19-21.)

As set forth in claim 22, the inclination angle of the helix is about 50° +/- 30° from horizontal. (¶ [0028], lines 21-22.)

As set forth in claim 23, the grain selector support (36) comprises a material capable of providing support to the grain selector (30) up to temperatures of about 3100°F. (¶ [0029], lines 7-10.)

As set forth in claim 24, the material comprises a high strength ceramic, a glass, graphite, and/or a refractory metal. (¶ [0029], lines 10-13.)

As set forth in claim 25, the grain selector (30) is positioned about the grain selector support (36). (¶ [0011], lines 15-18.)

As set forth in claim 26, the grain selector support (36) comprises a rod having a circular, square, rectangular, triangular, and/or oval cross-sectional shape. (¶ [0029], lines 13-17.)

As set forth in claim 27, the grain selector support (36) comprises a cross-sectional area of about $0.020in^2$ to about $0.25in^2$. (¶ [0029], lines 18-19.)

As set forth in claim 28, the single crystal investment cast component comprises a gas turbine engine component. (¶ [0007], lines 15-16.)

As set forth in claim 29, the investment casting system (10) comprises: a seed crystal (34) (¶ [0023], lines 4-6.); a grain selector (30) (¶ [0023], lines 4-6.) in operable communication with the seed crystal (34) (¶ [0008], lines 1-2.); and a grain selector support (36) (¶ [0029], lines 5-7.) capable of supporting at least a portion of weight bearing on the grain selector (30) (¶ [0029], lines 5-7.), wherein the system (10) is capable of creating a single crystal investment cast component (¶ [0031], lines 1-2.), and wherein the grain selector (30) comprises a non-linear tubular structure comprising a helix, a three-dimensional bend, a staircase, and/or a zigzag configuration. (¶ [0028], lines 6-10.)

As set forth in claim 30, the method for producing a high performance single crystal investment cast component comprises the steps of: disposing a seed crystal (34) within a seed crystal starter cavity (32) (¶ [0030], lines 3-4.); providing a grain selector (30) to operatively connect the seed crystal starter cavity (32) to a mold cavity (28) (¶ [0030], lines 4-5.); utilizing a grain selector support (36) to support the grain selector (30), the mold cavity (28), and any molten metal contained therein (¶ [0030], lines 5-6.); introducing molten metal into the mold cavity (28) (¶ [0030], lines 6-7.); allowing the molten metal to flow from the mold cavity (28), through the grain selector (30), and into the seed crystal starter cavity (32) (¶ [0030], lines 7-8.); epitaxially nucleating and growing a single crystal from the seed crystal (34) (¶ [0030], lines 8-9.); and utilizing the grain selector (30) in conjunction with the seed crystal (34) to grow only a single crystal up into the molten metal in the mold cavity (28) to yield the high performance single crystal investment cast component (¶ [0030], lines 9-12.), wherein the grain selector (30) comprises a non-linear tubular structure comprising a helix, a three-dimensional bend, a staircase, and/or a zigzag configuration (¶ [0028], lines 6-10.).

As set forth in claim 33, the high performance single crystal investment cast component comprises a gas turbine engine component. (¶ [0007], lines 15-16.)

As set forth in claim 34, the grain selector (30) is positioned about the grain selector support (36). (¶ [0011], lines 15-18.)

As set forth in claim 35, the grain selector support (36) comprises a rod. (¶ [0029], lines 13-17.)

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

The following grounds of rejection are to be reviewed on appeal: the rejection of claims 1-12, 15, 17-30 and 33-35 under §103(a) as being unpatentable over Monte I (US 5,062,468), Monte II (US 5,062,469) or Jeyarajan, and further in view of Burd; the rejection of claims 1-12, 15, 17-30 and 33-35 under §103(a) as being unpatentable over Burd and further in view of either Monte I (US 5,062,468), Monte II (US 5,062,469) or Jeyarajan; and the rejection of claims 1-12, 15, 17-30 and 33-35 under §103(a) as being unpatentable over Giamei and further in view of either Monte I (US 5,062,468), Monte II (US 5,062,469) or Jeyarajan or Burd.

VII. ARGUMENTS

The Monte I reference relied upon by the Examiner relates to molds for casting single crystal metal articles. The molds of Monte I include a mold cavity 18, a starter cavity 32, a single crystal selector 28 having a single bend section 42, and sometimes a support element 54 and/or a seed crystal (not assigned a reference number or shown in the figures in Monte I). The only crystal selectors 28 described in Monte I are described as having single two-dimensional bends. (*See* Monte I, col. 6, lines 32-42; col. 8, lines 22-31; col. 10, lines 26-28; col. 11, lines 4-25; col. 11, lines 52-61; col. 15, lines 7-17; col. 23, line 67 to col. 24, line 9.) As shown in FIGS. 1, 2, 4, 5 and 10 of Monte I, the only bends 42 shown in the various crystal selectors 28 are simple single two-dimensional bends.

Furthermore, Monte I actually teaches away from the more complex grain selector configurations (i.e., helix, three-dimensional bends, staircases, zigzags) of the present invention by noting how much less complicated the tooling is for the simpler configurations of Monte I, how much scrap is produced with helical grain selectors, and how expensive it is to cast single crystal articles utilizing helical grain selectors. (*See* Monte I, col. 8, lines 22-31; col. 1, lines 20-35.)

The Monte II reference relied upon by the Examiner also relates to molds for casting single crystal metal articles. The molds of Monte II include a mold cavity 18, a starter cavity 32, a single crystal selector 28 having a single bend section 42, and sometimes a support element 54 and/or a seed crystal (not assigned a reference number or shown in the figures in Monte II). The only crystal selectors 28 described in Monte II are described as having single two-dimensional bends. (*See* Monte II, col. 5, line 60 to col. 6, line 2; col. 10, lines 34-55; col. 14, lines 42-52; col. 19, lines 43-56.) As shown in FIGS. 1, 2, 4, 5 and 9 of Monte II, the only bends 42 shown in the various crystal selectors 28 are simple single two-dimensional bends.

Furthermore, Monte II also actually teaches away from the more complex grain selector configurations (i.e., helix, three-dimensional bends, staircases, zigzags) of the present invention by noting how much less complicated the tooling is for the simpler

configurations of Monte II, how much scrap is produced with helical grain selectors, and how expensive it is to cast single crystal articles utilizing helical grain selectors. (*See* Monte II, col. 7, lines 50-59; col.16 lines 13-23; col. 21, lines 9-13; col. 1, lines 17-22.)

The Jeyarajan reference relied upon by the Examiner relates to molds for casting single crystal metal articles. The molds of Jeyarajan include a mold cavity 18, a starter cavity 32, a single crystal selector 28 having a single bend section 42, and sometimes a support element 54. Jeyarajan never even mentions the possibility of using a seed crystal. The only crystal selectors 28 described in Jeyarajan are described as having single two-dimensional bends. (*See* Jeyarajan, col. 4, lines 28-31; col. 4, line 60 to col. 5, line 2; col. 9, lines 28-50; col. 11, lines 26-35.) As shown in FIGS. 1, 2 and 4 of Jeyarajan, the only bends 42 shown in the various crystal selectors 28 are simple single two-dimensional bends.

Furthermore, Jeyarajan actually teaches away from the more complex grain selector configurations (i.e., helix, three-dimensional bends, staircases, zigzags) of the present invention by noting how much less complicated the tooling is for the simpler configurations of Jeyarajan, how much scrap is produced with helical grain selectors, and how expensive it is to cast single crystal articles utilizing helical grain selectors. (*See* Jeyarajan, col. 1, lines 8-15; col. 1, lines 37-42; col. 4, lines 42-49.)

The Burd reference relied upon by the Examiner relates to molds for casting single crystal metal articles. The molds of Burd include a mold cavity 12, a starter chamber 20, a single crystal selector (tubular member 24), and a support element (central column 26). Burd never even mentions the possibility of using a seed crystal. The single crystal selectors (tubular member 24) described in Burd are described as being tubular passages having enough changes in direction to exclude all but the grain desired to continue through the ramp portion to the bottom of the article forming portion of the mold. (*See* Burd, col. 2, lines 20-31.) These tubular passages are then further described as being bent tubular passages having enough changes in direction in the horizontal plane for producing a change in direction of at least 180°. (*See* Burd, col. 2, lines 25-27.) These tubular passages are then further described as being helical. (*See* Burd, col. 2,

lines 36-48.) As shown in FIG. 1 of Burd, the single crystal selector (tubular member 24) is shown as being helical.

The Giamei reference relied upon by the Examiner relates to molds for casting single crystal metal articles. The molds of Giamei include a mold cavity (ceramic mold 34), a starter section 44, a single crystal selector (helical selector section 60), and a seed crystal 36. Giamei never even mentions the possibility of using a grain selector support. The single crystal selectors (helical selector section 60) described in Giamei are described as being shaped to cause the velocity vector of the solidification interface or front to rotate at least 90° in the x-y plane, preferably more than 180°, as it moves along the z axis through the section. (*See* Giamei, col. 2, lines 52-56.) These selector sections are then further described as being shaped as a helix, a zigzag or other inclined passageways. (*See* Giamei, col. 2, lines 56-60.) As shown in FIG. 7 of Giamei, the single crystal selector (helical selector section 60) is shown as being helical.

As presently claimed in Applicant's independent claims, Applicant's invention comprises at least these three elements: (a) a seed crystal, (b) a grain selector, and (c) a grain selector support, "wherein the grain selector comprises a non-linear tubular structure comprising at least one of: a helix, a three-dimensional bend, a staircase, and a zigzag." (*See* Applicants' independent claims 1, 29 and 30.)

In contrast, none of Monte I, Monte II or Jeyarajan disclose utilizing a seed crystal, a grain selector and a grain selector support, ***wherein the grain selector comprises a non-linear tubular structure comprising at least one of: a helix, a three-dimensional bend, a staircase, and a zigzag***. Each of Monte I, Monte II and Jeyarajan repeatedly disclose using a grain selector having only a ***simple single two-dimensional bend***. (*See, e.g.*, Monte I, col. 6, lines 34-42 and Figs. 2, 4 and 5; Monte II, col. 5, lines 60-68 and Figs. 2, 4, 5 and 9; and Jeyarajan, col. 4, lines 60-68 and Figs. 2 and 4.) While various embodiments of grain selectors are disclosed in each of Monte I, Monte II and Jeyarajan, all the disclosed embodiments only comprise a ***simple single two-dimensional bend***. No other configurations are disclosed or suggested anywhere in any of Monte I,

Monte II or Jeyarajan. Additionally, as previously noted, each of Monte I, Monte II and Jeyarajan actually ***teach away*** from the more complex grain selector configurations (i.e., helix, three-dimensional bends, staircases, zigzags) of the present invention by repeatedly noting how much less their simpler configurations cost, how much less complicated the tooling is for their simpler configurations, and how much scrap is produced with helical grain selectors. (*See, e.g.*, Jeyarajan, col. 4, lines 42-45; Monte I, col. 1, lines 20-35; and Monte II, col. 1, lines 17-34.)

Also in contrast, Burd does not disclose utilizing ***a seed crystal***, a grain selector and a grain selector support, wherein the grain selector comprises a non-linear tubular structure comprising at least one of: a helix, a three-dimensional bend, a staircase, and a zigzag. Burd never even mentions utilizing a seed crystal, and Burd only mentions utilizing a complex shaped (i.e., helical) grain selector.

Also in contrast, Giamei does not disclose utilizing a seed crystal, a grain selector and ***a grain selector support***, wherein the grain selector comprises a non-linear tubular structure comprising at least one of: a helix, a three-dimensional bend, a staircase, and a zigzag. Giamei never even mentions utilizing a grain selector support, and Giamei only mentions utilizing a complex shaped (i.e., helical or zig zag) grain selector.

Therefore, none of Monte I, Monte II, Jeyarajan, Burd or Giamei disclose, nor even suggest, utilizing a seed crystal, a grain selector and a grain selector support, wherein the grain selector comprises a non-linear tubular structure comprising at least one of: a helix, a three-dimensional bend, a staircase, and a zigzag, as recited in independent claims 1, 29 and 30 of Applicants' invention.

Obviousness is a legal conclusion based on four general types of underlying facts, all of which must be considered: (1) the scope and content of the prior art; (2) the differences between the claimed invention and the prior art; (3) the level of ordinary skill in the art; and (4) any objective indicia of nonobviousness. *See Graham v. John Deere Co.*, 383 U.S. 1, 17-18 (1966). It is well settled that when determining obviousness, the claimed invention must be considered as a whole, the references must be considered as a whole and ***must suggest the desirability ... of making the combination***, the references must be viewed without the benefit of ***impermissible hindsight vision*** afforded by the

claimed invention, and a reasonable expectation of success must exist. *See Hodosh v. Block Drug Co., Inc.*, 786 F.2d 1136, 1143 n.5, 229 USPQ 182, 187 n.5 (Fed. Cir. 1986). "The mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination.'" *See In re Mills*, 916 F.2d 680, 680-82, 16 USPQ2d 1430, 1430-32 (Fed. Circ. 1990). The Federal Circuit has produced a number of decisions overturning obviousness rejections due to a lack of suggestion in the prior art of the desirability of combining references. There is no suggestion or motivation in any of Monte I, Monte II, Jeyarajan, Burd or Giamei to modify any of the inventions as suggested by the Examiner. Furthermore, Applicants submit that the Examiner is relying upon impermissible hindsight vision afforded by Applicants' claimed invention to obtain his suggested combination of the cited references. As such, these rejections are improper.

Furthermore, references cannot be combined when a reference teaches away from their combination. *See In re Grasselli*, 713 F.2d 731, 743, 218 USPQ 769, 779 (Fed. Cir. 1983). Also, a prior art reference must be considered in its entirety, i.e., as a <u>whole</u>, ***including portions that would lead away from the claimed invention***. *See W.L. Gore & Associates, Inc. v. Garlock, Inc.*, 721 F.2d 1540, 220 USPQ 303 (Fed. Cir. 1983), *cert. denied*, 469 U.S. 851 (1984). As noted above, Monte I, Monte II and Jeyarajan actually teach away from complex grain selector configurations. Burd and Giamei only utilize complex grain selector configurations. Therefore, Monte I, Monte II and Jeyarajan actually teach away from Burd and Giamei. As such, one skilled in the art would not even look at Burd or Giamei to see if the Burd or Giamei inventions could be combined or modified in any way with Monte I, Monte II or Jeyarajan. Nor would one skilled in the art look at any of Monte I, Monte II or Jeyarajan to see if any of the inventions disclosed therein could be combined or modified in any way with Burd or Giamei. As such, these rejections are improper.

Finally, if Applicants' invention was as obvious as the Examiner claims it is, one of the cited references surely could have suggested or disclosed Applicants' invention somewhere therein. The fact that none of the cited references combined all the elements

as Applicants did is proof in and of itself that Applicants' invention is non-obvious. As such, these rejections are improper.

Based on the above arguments, Applicants respectfully submit that independent claims 1, 29 and 30 of the present invention are patentably distinguished from Monte I, Monte II, Jeyarajan, Burd and/or Giamei. As claims 2-12, 15 and 17-28 depend from claim 1; and claims 33-35 depend from claim 30; the discussion above applies to these claims as well. Further, these claims each include separate novel features. Thus, Applicants respectfully submit that pending claims 1-12, 15, 17-30 and 33-35 are patentable.

VIII. CONCLUSION

For the reasons discussed above, Appellants respectfully submit that the Examiner's rejections of claims 1-12, 15, 17-30 and 33-35 should be reversed and this application should be remanded to the Primary Examiner in Art Unit 1725 for allowance of claims 1-12, 15, 17-30 and 33-35.

As this Appeal Brief is being timely filed within three (3) months of July 26, 2006 (the date the Notice of Appeal was successfully transmitted via facsimile to the USPTO), Appellants believe that the only fees due are **$500** for the filing of the Appeal Brief and **$120** for a 1-Month Extension of Time. The Commissioner is authorized to charge this amount and any additional fees that may be due, or credit any overpayment, to **Deposit Account Number 21-0279, Order No. EH-11132**.

Respectfully submitted,

Date: October 26, 2006

Tracey R. Loughlin
Tracey R. Loughlin
Attorney for Appellants
USPTO Registration No. 51,969

EH-11132

PRATT & WHITNEY
Legal/Intellectual Property
400 Main Street
M/S 132-13
East Hartford, CT 06108
Telephone: 860-565-6127
Facsimile: 860-755-1867
E-mail: tracey.loughlin@pw.utc.com

RECEIVED
CENTRAL FAX CENTER
OCT 26 2006

CLAIMS APPENDIX

The claims currently pending in this application are as follows:

1. (Previously Presented) A system comprising:

an investment molding cavity;

a seed crystal starter cavity;

a seed crystal for initiating epitaxial crystal growth in molten metallic material that comes into contact therewith;

a grain selector operatively connecting the seed crystal starter cavity and the investment molding cavity for at least one of: (1) selecting a single crystal from the seed crystal to grow into the molten metallic material during solidification, or (2) ensuring that a single crystal from the seed crystal continues to grow into the molten metallic material during solidification; and

a grain selector support for at least partially supporting the weight of the investment molding cavity and any molten metallic material contained therein to take at least a portion of this weight off the grain selector,

wherein the system is capable of producing a single crystal investment cast component, and wherein the grain selector comprises a non-linear tubular structure comprising at least one of: a helix, a three-dimensional bend, a staircase, and a zigzag.

2. (Original) The system of claim 1, wherein the seed crystal comprises a single crystal grain structure.

3. (Original) The system of claim 1, wherein the seed crystal comprises a cross section of at least one of the following shapes: circle, square, rectangle, oval, semicircle, and polygon.

4. (Original) The system of claim 1, wherein the seed crystal comprises a cross-sectional area of about $0.0007in^2$ to about $0.625in^2$.

PAGE 18/25 * RCVD AT 10/26/2006 6:31:29 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-5/13 * DNIS:2738300 * CSID:8605659276 * DURATION (mm-ss):03-58

5. (Original) The system of claim 1, wherein the seed crystal comprises a height wherein the top of the seed crystal extends into the furnace far enough that a temperature of the top of the seed crystal exceeds a liquidus temperature of the seed crystal, while a temperature of the bottom of the seed crystal remains below a solidus temperature of the seed crystal.

6. (Original) The system of claim 1, wherein the seed crystal comprises <001> primary and secondary crystallographic orientations.

7. (Original) The system of claim 1, wherein the seed crystal comprises a <111> primary orientation and a <112> or a <110> secondary crystallographic orientation.

8. (Original) The system of claim 1, wherein a secondary orientation of the seed crystal is aligned with a predetermined crystal plane dictated by a casting feature where controlled secondary orientation is desired.

9. (Original) The system of claim 1, wherein the seed crystal comprises at least one of the following: a nickel-based superalloy, an iron-based superalloy, a cobalt-based superalloy, and a refractory-based superalloy.

10. (Original) The system of claim 1, wherein the seed crystal comprises at least one of the following alloying elements: cobalt (Co), chromium (Cr), carbon (C), iron (Fe), titanium (Ti), tantalum (Ta), aluminum (Al), molybdenum (Mo), tungsten (W), boron (B), niobium (Nb), zirconium (Zr), hafnium (Hf), yttrium (Y), rhodium (Rh), rhenium (Re), lanthanum (La), manganese (Mn), and silicon (Si), with the balance comprising nominal impurities and at least one of: nickel (Ni), iron (Fe), and cobalt (Co).

11. (Original) The system of claim 1, wherein the seed crystal comprises about 5 wt. % chromium, about 10 wt. % cobalt, about 5.6 wt. % aluminum, about 1.9 wt.

% molybdenum, about 5.9 wt. % tungsten, about 0.1 wt. % hafnium, about 8.7 wt. % tantalum, and about 3.0 wt. % rhenium, with the balance comprising nickel.

12. (Original) The system of claim 1, wherein the seed crystal comprises a predetermined melting point such that the molten metallic material that comes into contact therewith melts back a portion of the seed crystal during casting.

13. (Cancelled)

14. (Cancelled)

15. (Original) The system of claim 1, wherein the grain selector comprises a non-linear tubular structure connecting the seed crystal starter cavity to the investment molding cavity.

16. (Cancelled)

17. (Previously Presented) The system of claim 1, wherein the non-linear tubular structure comprises at least one of the following cross-sectional shapes: a circle, an oval, a triangle, a rectangle, a square, and a polygon.

18. (Previously Presented) The system of claim 1, wherein the non-linear tubular structure comprises a passageway therein having a cross-sectional area of about $0.00025in^2$ to about $0.50in^2$.

19. (Previously Presented) The system of claim 1, wherein the non-linear tubular structure comprises a passageway therein having a cross-sectional area no greater than about 1/9 a size of a surface area of a surface of the seed crystal to which the non-linear tubular structure is connected.

20. (Previously Presented) The system of claim 1, wherein the helix comprises about 0.25 to about 10 turns per inch.

21. (Previously Presented) The system of claim 1, wherein the helix comprises about 0.25 to about 10 turns total so that about 90° to about 3600° of rotation occurs from one end of the helix to the other.

22. (Previously Presented) The system of claim 1, wherein an inclination angle of the helix is about 50° +/- 30° from horizontal.

23. (Original) The system of claim 1, wherein the grain selector support comprises a material capable of providing support to the grain selector up to temperatures of about 3100°F.

24. (Original) The system of claim 23, wherein the material comprises at least one of: a high strength ceramic, a glass, graphite, and a refractory metal.

25. (Original) The system of claim 1, wherein the grain selector is positioned about the grain selector support.

26. (Original) The system of claim 1, wherein the grain selector support comprises a rod with at least one of the following cross-sectional shapes: circular, square, rectangular, triangular, and oval.

27. (Original) The system of claim 1, wherein the grain selector support comprises a cross-sectional area of about $0.020in^2$ to about $0.25in^2$.

28. (Original) The system of claim 1, wherein the single crystal investment cast component comprises a gas turbine engine component.

29. (Previously Presented) A system comprising:

a seed crystal;

a grain selector in operable communication with the seed crystal; and

a grain selector support capable of supporting at least a portion of weight bearing on the grain selector,

wherein the system is capable of creating a single crystal investment cast component, and wherein the grain selector comprises a non-linear tubular structure comprising at least one of: a helix, a three-dimensional bend, a staircase, and a zigzag.

30. (Previously Presented) A method for producing a high performance single crystal investment cast component, the method comprising the steps of:

disposing a seed crystal within a seed crystal starter cavity;

providing a grain selector to operatively connect the seed crystal starter cavity to a mold cavity;

utilizing a grain selector support to support the grain selector, the mold cavity, and any molten metal contained therein;

introducing molten metal into the mold cavity;

allowing the molten metal to flow from the mold cavity, through the grain selector, and into the seed crystal starter cavity;

epitaxially nucleating and growing a single crystal from the seed crystal; and

utilizing the grain selector in conjunction with the seed crystal to grow only a single crystal up into the molten metal in the mold cavity to yield the high performance single crystal investment cast component,

wherein the grain selector comprises a non-linear tubular structure comprising at least one of: a helix, a three-dimensional bend, a staircase, and a zigzag.

31. (Cancelled)

32. (Cancelled)

33. (Original) The method of claim 30, wherein the high performance single crystal investment cast component comprises a gas turbine engine component.

34. (Original) The method of claim 30, wherein the grain selector is positioned about the grain selector support.

35. (Original) The method of claim 34, wherein the grain selector support comprises a rod.

EVIDENCE APPENDIX

Not Applicable.

RELATED PROCEEDINGS APPENDIX

Not Applicable.

RECEIVED
CENTRAL FAX CENTER

OCT 2 6 2006

PTO/SB/17 (12-04)
Approved for use through 07/31/2006. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number

Effective on 12/08/2004.
Fees pursuant to the Consolidated Appropriations Act, 2005 (H.R. 4818).

FEE TRANSMITTAL
For FY 2005

☐ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT	($) 620

Complete if Known	
Application Number	10/809,072
Filing Date	March 25, 2004
First Named Inventor	Steven J. Bullied et.al
Examiner Name	Kuang Y. Lin
Art Unit	1725
Attorney Docket No.	PA-085.11132-US (EH-11132)

METHOD OF PAYMENT (check all that apply)

☐ Check ☐ Credit Card ☐ Money Order ☐ None ☐ Other (please identify): ______

☑ Deposit Account Deposit Account Number: 21-0279 Deposit Account Name: Pratt & Whitney

For the above-identified deposit account, the Director is hereby authorized to: (check all that apply)

☑ Charge fee(s) indicated below ☐ Charge fee(s) indicated below, except for the filing fee

☑ Charge any additional fee(s) or underpayments of fee(s) under 37 CFR 1.16 and 1.17 ☑ Credit any overpayments

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

FEE CALCULATION

1. BASIC FILING, SEARCH, AND EXAMINATION FEES

Application Type	FILING FEES Fee ($)	FILING FEES Small Entity Fee ($)	SEARCH FEES Fee ($)	SEARCH FEES Small Entity Fee ($)	EXAMINATION FEES Fee ($)	EXAMINATION FEES Small Entity Fee ($)	Fees Paid ($)
Utility	300	150	500	250	200	100	
Design	200	100	100	50	130	65	
Plant	200	100	300	150	160	80	
Reissue	300	150	500	250	600	300	
Provisional	200	100	0	0	0	0	

2. EXCESS CLAIM FEES

Fee Description	Fee ($)	Small Entity Fee ($)
Each claim over 20 or, for Reissues, each claim over 20 and more than in the original patent	50	25
Each independent claim over 3 or, for Reissues, each independent claim more than in the original patent	200	100
Multiple dependent claims	360	180

Total Claims: 0 - 20 or HP = Extra Claims: 0 x Fee ($): 50 = Fee Paid ($): 0

HP = highest number of total claims paid for, if greater than 20

Indep. Claims: 0 - 3 or HP = Extra Claims: 0 x Fee ($): 200 = Fee Paid ($): 0

HP = highest number of independent claims paid for, if greater than 3

Multiple Dependent Claims: Fee ($): 0 Fee Paid ($): 0

3. APPLICATION SIZE FEE

If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets ______ - 100 = Extra Sheets ______ / 50 = Number of each additional 50 or fraction thereof ______ (round up to a whole number) x Fee ($) ______ = Fee Paid ($) ______

4. OTHER FEE(S) Fees Paid ($)

Non-English Specification, $130 fee (no small entity discount) ______

Other: 1 month extension of time ($120) and Filing an Appeal Brief ($500) 620.00

SUBMITTED BY			
Signature	Tracey R Loughlin	Registration No. (Attorney/Agent) 51,969	Telephone 860-565-6127
Name (Print/Type)	Tracey R Loughlin		Date October 26, 2006

This collection of information is required by 37 CFR 1.136. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

RECEIVED
CENTRAL FAX CENTER
OCT 2 6 2006

CERTIFICATE OF TRANSMISSION

Date of Transmission:	October 26, 2006
Type of Document(s):	- Fee Transmittal (PTO/SB/17) (1 page) - Appeal Brief (21 pages) - Petition for 1 Month Extension of Time (2 copies)
Serial No.:	10/809,072
Inventors:	BULLIED et al.
Title:	Single Crystal Investment Cast Components and Methods of Making Same
File Reference:	EH-11132

I hereby certify that the documents identified above are being facsimile transmitted to the United States Postal Service at **571-273-8300** on the date indicated above, addressed to: **Mail Stop Appeal Brief - Patents, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Tracey R. Loughlin

Tracey R. Loughlin